GEOTECHNICAL ENGINEERING REPORT

LOS CAPITANCILLOS FRESHWATER
WETLAND MITIGATION PROJECT
SANTA CLARA VALLEY WATER DISTRICT
SANTA CLARA COUNTY, CALIFORNIA

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GEOTECHNICAL ENGINEERING REPORT
LOS CAPITANCILLOS FRESHWATER WETLAND MITIGATION PROJECT
SANTA CLARA VALLEY WATER DISTRICT
SANTA CLARA COUNTY, CALIFORNIA

For

Philip Williams & Associates, Ltd.
770 Tamalpais Drive, Suite 401
Corte Madera, CA 94925

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October, 2001

Job No. 99154.10

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- *Geotechnical*
- *Environmental*
- *Materials Testing*
- *Construction Inspection*

Philip Williams & Associates
Consultants in Hydrology
770 Tamalpais Drive, Suite 401
Corte Madera, CA 94925

October 16, 2001
Job No. 99154.10

Attn: Mark Lindley

Sub: Los Capitancillos Freshwater Wetland Mitigation Project

Dear Mr. Lindley:

This letter presents the response to your memorandum, dated September 25, 2001. Based on this memorandum, PWA is requesting Parikh Consultants, Inc., to prepare a brief report that provides geotechnical engineering analyses and recommendations that will be included in the Engineer's report. The following issues were requested:

1. Wetland Soil Cover Specifications.
2. Stability, Bulking and Compaction.
3. Erosion Control.
4. Seepage Analysis.

Per your request, a separate letter will follow, which will present the groundwater monitoring data, at piezometers B-1 to B-3 from May 2000 to August 2001.

We have had several discussions with your office in regards to these elements of work. We believe that there should be a clarification as to the intent of the soil cover (liner) from an engineering perspective and vegetation perspective. As we understand, the intent of the liner is to allow certain level of percolation, maintain overall slope stability and facilitate vegetation growth. However, in order to meet the engineering criteria the soil may need to be coarse-grained and compacted to a 90% to 95% relative compaction. This could meet the percolation and slope stability requirements, however it may not be favorable for growing vegetation. If a fine-grained material is used and is compacted to relatively low compaction, it may not be stable enough or permeable enough to meet the percolation criteria or keep the pond liner stable. In order to meet both these criteria it is suggested to design the liner to meet the engineering criteria and overlay with the appropriate "growing medium" for the vegetation. The reduction in percolation due to the "growing medium" would have to be accounted for in the overall calculations. Based on this understanding we have provided discussions and recommendations in this report.

It should be recognized that, once the pond is in use, it will tend to collect fine-grained soil over a period of time. This will ultimately "choke" the liner unless routine maintenance is performed to rejuvenate the liner. This "choking" process will accelerate even more with the wetland mitigation program and vegetation since the plant material will disintegrate and add to the impermeability of the liner. Additional concepts such as installation of shallow standpipes (which penetrate through the liner into native soil) may be explored. This could allow percolation through the native soil while protecting the "openings" from sediments. This concept will depend on the ultimate goal or program for the pond.

Wetland Soil Cover Specifications

As discussed above, the design of the proposed wetland soil cover is intended to satisfy different but interrelated requirements:

(a) Hydrologic objectives: Per the information provided by PWA, in order to balance inflows with losses, the target percolation rate of the cover should be 0.2 to 0.3 ft/day (1.4 to $2.1\mathrm{X}10^{-4}$ ft/min).

(b) Vegetation establishment: The soil cover should support emergent wetland plant growth in the upper 12 inches at the tall emergent wetland areas and allow the colonization of the upper 4 inches of the sediment by feeding and burrowing species at the open water habitat areas. Design recommendations to meet these criteria are beyond our scope and expertise.

(c) Structural integrity: The soil cover should be properly compacted and have at least the minimum required thickness in order to be functional from an engineering perspective.

We believe that since the underlying on-site soil material is known to be highly permeable, the soil cover should be designed using a rather conservative approach. Consequently, we recommend that it would be more effective to construct the soil cover using a relatively coarse material (clayey sand or silty sand) properly compacted (90 to 95% Relative Compaction) rather than a finer material (e.g. silt, sandy clay loam) that would be moderately compacted (≤85% Relative Compaction). Based on the available published literature and our experience, we believe that such a material (clayey sand or silty sand) compacted to 90-95% Relative Compaction per ASTM specifications should yield a percolation rate on the order of 10^{-4} to 10^{-5} ft/min, which is close to the target percolation rate. The minimum thickness for the compacted soil cover should be no less than 12 inches, in order to be more resistant against differential settlements and in order to minimize cracks.

As discussed earlier, this base soil cover may not meet the criteria for the establishment of the vegetation. For this purpose, we recommend that an additional layer of 6 to 12 inches of appropriate soil be placed and moderately compacted on top of the base soil cover in the riparian/tall emergent wetland areas. This layer should be sufficient to support the growth of the wetland plants, since the majority of the root biomass related to the target wetland species typically occurs in the upper 12 inches of soil. As per the open water habitat areas, the subsurface deposits feeding and burrowing species likely to colonize the site generally occur within the upper 4 inches of sediment. Consequently, we recommend a 4-inch thick layer of appropriate "non-engineered" soil to be placed on top of the base cover in order to satisfy this requirement. The nature of the soil in these proposed "growing media" should be determined based on vegetation and/or other criteria, which are beyond our scope of work.

Grade specifications regarding the grain size distribution of the proposed soil cover (base layer) are as follows:

Sieve Size	**Proposed Operating Range (Percentage passing)**
38 mm (1.5")	100
13 mm (0.5")	75-100
4.75 mm (#4)	50-80
75 µm (#200)	10-25

In addition, the material should be relatively non-expansive, granular, having a minimum Sand Equivalent of 21, and should be reviewed by the engineer.

It is not possible to develop or recommend different mix specifications for the base soil cover. This should be a "design-build" criterion that identifies the minimum percolation range at a specified relative compaction. This approach allows the contractor to find the proper soil types to meet the project needs.

Therefore it is imperative that the contractor understands that it is his responsibility to find the source and provide the appropriate soil material that meets the above grading and quality requirements. In addition, the material should be laboratory tested in advance by the contractor at different values of Relative Compaction (recommended range is 90 to 95%) and proven to satisfy the percolation criterion. A quality assurance program should be considered during construction, in order to verify that all performance criteria are met.

We should note that special consideration should be given for the long-term performance of the wetland. Organic material, dust and/or debris will be accumulating at the bottom of the wetland over the years because of the plants, the wind blown debris, human activities, etc. In addition, decomposition of organic substances will facilitate the creation of a layer on the bottom of the wetland, which may dramatically alter the initial design assumptions regarding the wetland hydrologic performance. For this purpose, we recommend that the design account for soil depositions and appropriate maintenance.

Stability, Bulking and Compaction

We have already performed slope stability analyses (static case and pseudostatic case – 0.12g & 0.20g), which were presented in our final report, dated December 7, 2000. We have conducted the slope stability analysis using the program PCSTABL. The slope stability analysis method described by the U.S. Army Corps of Engineers is mainly applicable for earth levees, so it was not used for the needs of this project.

Please, note also that in our slope stability evaluation we have assumed a 2:1 continuous slope with a maximum height of 20 feet. These preliminary assumptions considered are apparently more conservative than the actual profile shown in the conceptual cross-section provided by PWA (4:1 (H:V) maximum slope, 8 feet-high). Consequently, we believe that the stability of the wetland slopes should not be a major concern.

Geotechnical recommendations for compaction of the soil cover are provided in the previous section, "Wetland Soil Cover Specifications". Areas to receive engineered fill should be excavated to remove any and all loose/soft soils. The resulting surface upon which fill is to be placed should be observed by the engineer. Areas receiving fill should be scarified, moisture conditioned and compacted to 95% Relative Compaction per ASTM specifications.

Erosion Control

The base soil cover will be covered with "growing medium" for vegetation and surface treatment. This material should be designed to mitigate surface erosion. Also, seasonal water fluctuation should be considered so that the top cover does not crack and swell resulting in rapid degradation.

Seepage Analysis

We have conducted a seepage analysis for the proposed base soil cover. The software program used for the analysis was SEEP2D, which is a two-dimensional finite element analysis program. The soil profile provided by PWA on Figure 3, Conceptual Cross-Section AA', formed the basis of our analysis. Only deviation from the above geometry was that a uniform thickness of one-foot was used for the soil cover throughout the cross-section, instead of a varying thickness of 1 to 1.5 feet. The concept was that any soil layer placed and moderately compacted on top of the one-foot base cover (e.g. for vegetation establishment) will not contribute significantly on retention, in other words percolation rate would probably be controlled by the recommended one-foot thick compacted base soil cover. For our analysis we considered that the water level in the wetland remains at Elev. +243 feet. We also placed the groundwater table at Elev. +236 feet, corresponding to a depth of 8 feet below the ground surface (ground elev. +244 feet at the conceptual drawing). This matches with the highest water level measured, according to our ground water monitoring (February 21, 2001).

The analysis was performed for unconfined conditions, considering flow in the saturated and the unsaturated zone. We assumed isotropy and homogeneity. The borderline between saturated and vadose zone (ground water table) is shown on the attached Figure 1, Pressure Head, as the line corresponding to pressure head equal to zero. Figure 2, presents the flowline pattern. Figure 3 shows the equipotential lines, which range from Total Head=243 feet at the wetland surface to Total Head=236 at the boundaries of the profile. Total flowrate from the wetland was calculated on the order of 132 $(ft^3/day)/ft$, using a target percolation rate of 0.3 ft/day for the soil cover.

In conclusion, a one-foot thick soil cover with the specifications presented herein, placed over the whole area of the proposed wetland should satisfy the needs for hydrologic performance and structural integrity. On top of this base cover we recommend another layer, with a varying thickness between 4 inches (deep open water areas) and 12 inches (tall emergent wetland/riparian areas), which should be moderately compacted and should serve for the colonization by the feeding and burrowing species and vegetation establishment, respectively.

Warranty: Please be advised that we are performing a professional service and that our conclusions are professional opinion only. All work done and all recommendations made are in accordance with generally accepted geotechnical engineering principles and practices. No warranty, expressed or implied, of merchantability or fitness, is made or intended in connection with our work.

If you have any questions, please feel free to contact this office.

Very truly yours,
PARIKH CONSULTANTS, INC.

Apostolos V. Kozompolis

Apostolos V. Kozompolis
Staff Engineer

Gary Parikh, P.E., G.E. 666
Project Manager

REGISTERED PROFESSIONAL ENGINEER
GAURANG R. PARIKH
No. 666
EXP. 12-31-01
GEOTECHNICAL
STATE OF CALIFORNIA

Attachments: Plate No. 1, Pressure Head
Plate No. 2, Flowlines
Plate No. 3, Equipotential Lines

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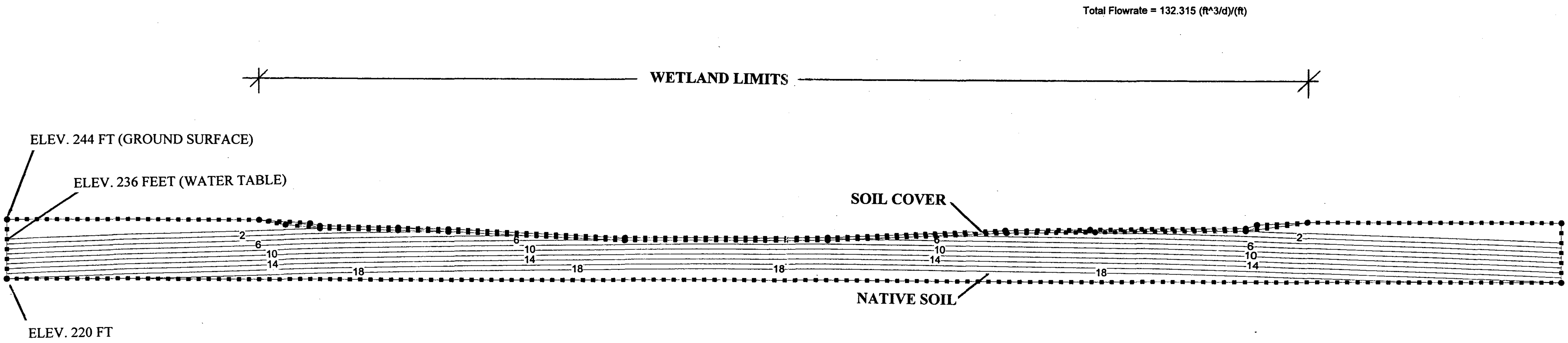
LOS CAPITANCILLOS FRESHWATER WETLAND MITIGATION PROJECT
SEEPAGE ANALYSIS


Total Flowrate = 132.315 (ft^3/d)/(ft)
WETLAND LIMITS
ELEV. 244 FT (GROUND SURFACE)
ELEV. 236 FEET (WATER TABLE)
SOIL COVER
2
6
10
14
18
NATIVE SOIL
ELEV. 220 FT

LEGEND:

SCALE: 1 INCH = 40 FEET

CONTOURS REPRESENT PRESSURE HEAD IN FEET
NOTE: "0" PRESSURE CONTOUR CORRESPONDS TO GROUND WATER TABLE

PRESSURE HEAD

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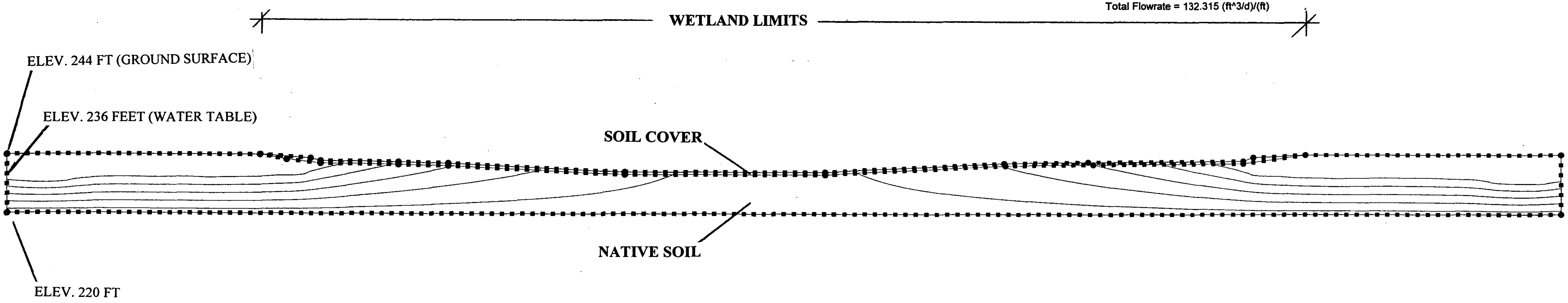
JOB NO.: 99154.10

PLATE NO.: 1

LOS CAPITANCILLOS FRESHWATER WETLAND MITIGATION PROJECT
SEEPAGE ANALYSIS


Total Flowrate = 132.315 (ft^3/d)/(ft)
WETLAND LIMITS
ELEV. 244 FT (GROUND SURFACE)
ELEV. 236 FEET (WATER TABLE)
SOIL COVER
NATIVE SOIL
ELEV. 220 FT

LEGEND:

SCALE: 1 INCH = 40 FEET

NOTE:
FLOWLINES DEFINE FLOW PATHS THROUGH SOIL MEDIA

FLOWLINES

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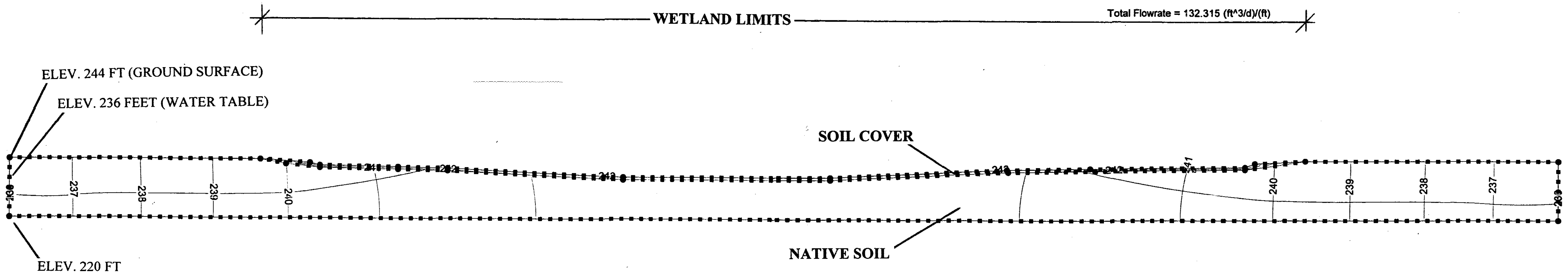
PLATE NO.: 2

LOS CAPITANCILLOS FRESHWATER WETLAND MITIGATION PROJECT
SEEPAGE ANALYSIS


WETLAND LIMITS
Total Flowrate = 132.315 (ft^3/d)/(ft)
ELEV. 244 FT (GROUND SURFACE)
ELEV. 236 FEET (WATER TABLE)
SOIL COVER
ELEV. 220 FT
NATIVE SOIL
236
237
238
239
240
241
242
243
243
242
241
240
239
238
237
236

LEGEND:

SCALE: 1 INCH = 40 FEET

EQUIPOTENTIAL LINES REPRESENT DROPS IN TOTAL HEAD (FEET).
TOTAL HEAD RANGES BETWEEN 243 (WETLAND SURFACE) AND 236 (WATER TABLE)

EQUIPOTENTIAL LINES

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JOB NO.: 99154.10	PLATE NO.: 3